U.S. Army Research Institute
for the Behavioral and Social Sciences

Research Report 1859

A Simulation-Based Tool to Train Rapid Decision-Making Skills for the Digital Battlefield

Rick Archer, Alan T. Brockett, Patricia L. McDermott, and Walter Warwick
Micro Analysis & Design, Inc.

Richard E. Christ
U.S. Army Research Institute

August 2006

U.S. Army Research Institute
for the Behavioral and Social Sciences

A Directorate of the Department of the Army
Deputy Chief of Staff, G1

Authorized and approved for distribution:

STANLEY M. HALPIN	**MICHELLE SAMS**
Acting Technical Director	**Acting Director**

Research accomplished under contract
for the Department of the Army

Micro Analysis & Design, Inc.

Technical reviewed by

John S. Barnett, U.S. Army Research Institute
James Belanich, U.S. Army Research Institute
Gregory A. Goodwin, U.S. Army Research Institute

NOTICES

REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy) August 2006	2. REPORT TYPE Final	3. DATES COVERED (from. . . to) January 2004 – March 2006
4. TITLE AND SUBTITLE A Simulation-based Tool to Train Rapid Decision-Making Skills for the Digital Battlefield		5a. CONTRACT OR GRANT NUMBER DASW01-04-C-0007 5b. PROGRAM ELEMENT NUMBER 665502
6. AUTHOR(S) Rick Archer, Alan T. Brockett, Patricia L. McDermott, and Walter Warwick (Micro Analysis & Design, Inc.); Richard E. Christ (U.S. Army Research Institute)		5c. PROJECT NUMBER M770 5d. TASK NUMBER 215 5e. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Micro Analysis & Design, Inc. 4949 Pearl East Circle, Suite 300 Boulder, CO 80301		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences ATTN: DAPE-ARI-IJ 2511 Jefferson Davis Highway Arlington, Virginia 22202-3926		10. MONITOR ACRONYM ARI 11. MONITOR REPORT NUMBER Research Report 1859

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES
Contracting Officer's Representative and Subject Matter POC: Dr. Richard E. Christ

14. ABSTRACT *(Maximum 200 words)*:
This report was developed under the Army Phase II Small Business Innovation Research (SBIR) program. The Simulated Field Exercise (SimFX) tool was designed to help small unit leaders make good decisions while immersed in an ever widening array of information technologies. Rather than focus training on the specifications and capabilities of new technologies, we provide students with computer-based scenarios that force them to resolve ambiguous or contradictory input from remote sensors, fuse disparate sources of information, filter information, and manage resources. SimFX exploits the cognitive realism that comes from engaging a trainee in a branching story in which the trainee must make a series of decisions that ultimately affect how the story plays out. The consequences and feedback are predicated not just on the alternative chosen but on the information sources used to make the decision. Thus, emphasis is placed on the student's ability to collect and use information. SimFX consists of two components: the Player presents a scenario to the trainee and the Author allows training developers to create story-based scenarios or deliberate practice exercises. SimFX is a low-cost, easy to use training tool that has been favorably received by potential users in the Army training community.

15. SUBJECT TERMS
Training Decision Making Training Simulation Outcome-Driven Simulation
Future Force Digital Battlefield Authorable Simulation Infantry Operations Army Phase II SBIR Report

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON
16. REPORT Unclassified	17. ABSTRACT Unclassified	18. THIS PAGE Unclassified	Unlimited	56	Ellen Kinzer Technical Publication Specialist (703) 602-8047

Standard Form 298

Research Report 1859

A Simulation-based Tool to Train Rapid Decision-Making Skills for the Digital Battlefield

Rick Archer, Alan T. Brockett, Patricia L. McDermott, and Walter Warwick
Micro Analysis & Design, Inc.

Richard E. Christ
U.S. Army Research Institute

Infantry Forces Research Unit
Scott E. Graham, Chief

U.S. Army Research Institute for the Behavioral and Social Sciences
2511 Jefferson Davis Highway, Arlington, VA 22202-3926

August 2006

Army Project Number
665502M770

Small Business Innovation Research (SBIR) Program

ACKNOWLEDGMENTS

We thank the Army training and training developer personnel who served as members of a sounding board that provided input on an early conception of the SimFX tool. We acknowledge our military subject matter experts, Rich Adkins and Gary Lawrence, for the domain expertise they brought to our demonstration scenario development. We give recognition to the beta testers who provided feedback on SimFX, especially those who participated in the hands-on workshop conducted at Fort Benning, Georgia. Finally, we extend special thanks to Steve Livingston of Northrop Grumman Corporation, whose efforts and suggestions for improvement were invaluable in helping us make the authoring component of SimFX as useful and usable as possible.

A SIMULATION-BASED TOOL TO TRAIN RAPID DECISION-MAKING SKILLS FOR THE DIGITAL BATTLEFIELD

EXECUTIVE SUMMARY

Research Requirement:

The U.S. Army's Future Force Warrior program exploits opportunities made possible by advances in our capacity to quickly gather, organize, and distribute battlespace information available from multiple sensor and database systems. As this transfer of information and communication technology into the Future Force is planned and executed, there is a concurrent need to develop training tools that will enhance the cognitive skills required to make rapid decisions in the future information-rich operating environment. This report documents research that developed a computer-based simulation tool, called the Simulated Field Exercise (SimFX) tool, to train small unit leaders to resolve ambiguous or contradictory sensor readings, fuse disparate sources of information, and employ remote sensors – whether robotic or human – to the greatest effect in a tactical situation.

Procedure:

The development of the SimFX software was guided by adherence to three major themes and techniques. SimFX uses outcome-driven simulation that exploits the cognitive realism that results from engaging students in a story or vignette in which they make a series of decisions that affect how the story plays out. The development of branching storylines give the students access to multiple sources of some times potentially conflicting information at each decision point and advance them from one decision point to the next. Finally, several techniques were used to minimize the combinatory explosion that could occur keeping track of the multiple paths that are possible though the storyline.

Findings:

The principle product of this research was the SimFX software application that consists of two components. The Author component helps training developers to create and modify branching storylines, each composed of linked decision nodes that form the basis for training scenarios that will achieve the objectives of their respective training programs. The Player component presents the training scenarios to the student and records their decisions and the decision outcomes. The research also produced separate hard copy user guides and tutorials for the user of the Author and the Player components of SimFX. The usability and potential effectiveness of both SimFX components have received favorable reactions from participants in a series of beta tests, to include a hands-on workshop conducted for a broad cross section of trainers and training developers at Fort Benning, Georgia.

Utilization and Dissemination of Findings:

The SimFX tool and the results of a preliminary training evaluation of SimFX have been presented to senior leaders of Infantry training and training development at Fort Benning, Georgia. The use of existing and some newly created SimFX training scenarios is being investigated in ongoing research at Fort Benning for training Infantry squad and platoon leaders. Further, a series of hands-on workshops is being conducted across Fort Benning and elsewhere to ensure that trainers and training developers are aware of how they can use SimFX to contribute to their respective training objectives.

A SIMULATION-BASED TOOL TO TRAIN RAPID DECISION-MAKING SKILLS FOR THE DIGITAL BATTLEFIELD

CONTENTS

LIST OF FIGURES

A SIMULATION-BASED TOOL TO TRAIN RAPID DECISION-MAKING FOR THE DIGITAL BATTLEFIELD

Introduction

Background

The Infantry Forces Research Unit of the U.S. Army Research Institute for the Behavioral and Social Sciences has been conducting research to evaluate the training potential of desktop simulations of dismounted Infantry operations (Beal, 2005; Beal & Christ, 2004, 2005; and Centric, Beal, & Christ, 2005). The desktop simulations evaluated were developed to provide Infantry leaders with opportunities to experience realistically the consequences of executing an operations order and the challenges inherent in making hasty changes to those orders in response to emerging tactical conditions in the current or contemporary operating environment However, in keeping with the Army's modernization plan, there is a need to develop and evaluate desktop training tools that can enhance the types of cognitive skills required to make rapid decisions in the projected future operating environment. The Army's Future Force concept exploits the enormous opportunities made possible by advances in our capacity to quickly gather, organize, and distribute battlespace information.

Several years ago the Infantry Forces Research Unit developed a topic statement for the Small Business Innovation Research (SBIR) program that asked for the development of a computer-based system that could be used to train rapid decision-making skills of small unit leaders regardless of the level of technology used in their operating environment. The training tool was to be initially developed for use by dismounted Infantry platoon leaders but also to have the capability to be used by leaders at both higher and lower echelons. The objective of the new training tool was to develop the leader's ability to access, integrate, and effectively use information from multiple sources to improve his decision-making proficiency. Special importance was placed on the role of the information provided or available to help the leader make the best possible decisions, without concern for the format and structure of the information (i.e., its analog or digital format) or the means by which the information was presented (i.e., the user-system interface or "knobology"). Finally, the training tool was to be capable of operating on any Microsoft Windows operating system and to use training scenarios that could be developed by training developers without special software development skills. Based on the quality of the background work and plans accomplished during a Phase I effort, a Phase II SBIR contract for this topic was awarded to Micro Analysis and Design, Inc.

Products of the Phase II SBIR Contract

The principal product of this SBIR contract meets all the objectives of the SBIR topic. The principal product is a software application, titled *Simulated Field Exercise (SimFX) Tool*. In addition to the SimFX software, we produced a user guide and tutorial for those who would train using SimFX, the *SimFX Player User Guide and Tutorial*, and

a companion document for the training developer, the *SimFX Author User Guide and Tutorial*[1]. A compact disc containing the SimFX software and printed copies of the two user guides and tutorials (viz., Archer, Brockett, McDermott, & Warwick, 2006a, 2006b, 2006c) are available with distribution limited to U.S. Government Agencies only until March 31, 2010. These research products can be obtained from the Private Scientific and Technical Information Network (STINET) of the Defense Technical Information Center (DTIC). The two user guides and tutorials are also contained in the SimFX tool compact disc.

Purpose of This Report

In keeping with the requirements of the SBIR contract, this research report was developed to document the Phase II work in a final report that would be available for unlimited and unrestricted distribution from DTIC's public STINET. Consequently, this report describes (a) some significant questions that we had to resolve as we began this research and development effort, (b) the rationale and approach used in developing the SimFX tool, (c) the SimFX tool itself, and (d) the results of efforts we undertook to evaluate the usability of SimFX.

Questions Raised by the Need to Train Leaders to Use Technologies Still in Development

Since the transformation in technologies required to support the digital battlefield projected for the Future Force is not yet complete, we had to confront two significant questions as we developed methods that could be used today to train a warrior using tomorrow's technology. First, there was a question of whether the transformation in technology would lead to a shift in the nature of the small unit leader's tactical decision making. The very fact that the original solicitation called for the development of new training methodologies suggested that the problem here might not just be a question of familiarizing the warrior with new pieces of digital equipment – the knobology of a system – but rather that decision-making processes that were once intuitive might become more analytical as more information is presented to the small unit leader.

Second, having originally proposed a simulation-based approach, we had to address the question of how much realism would be needed in the simulation to ensure an engaging training experience in which the appropriate skills would be acquired. As computers have become cheaper and more powerful, the trend in simulation-based training has been to create increasingly immersive "virtual realities" on the assumption that a highly realistic simulation environment will, *ipso facto*, ensure that the appropriate training occurs (i.e., the student will not simply learn how to "game" the simulation). While an immersive flight simulator might provide the student an opportunity to learn the subtle perceptual and motor skills needed to keep an airplane in the air, it was not clear to us that a similar approach would help an Infantry leader to develop the cognitive skills required to fuse information from various sources.

---

[1] In this report, the user of the training component of SimFX is called the trainee, student, or leader. The user of the authoring component of SimFX is called the author, trainer, or training developer.

In fact, this insight helped us see the relationship between these two questions. More specifically, we recognized that the development of a highly realistic simulation of technologies that do not yet exist is not only self-defeating, but also unnecessary. Instead, we pursued development of a cognitively engaging simulation environment, in which information could be presented rather abstractly (i.e., independently of the user-system interface or knobology of an envisioned system) so that a leader would be forced to make decisions under specific conditions. This approach reflects the view that repeated experience is the best way to train decision-making skills so that a required cognitive process that might initially be analytic and labored can become more intuitive and automatic. Role of practice and feedback on the development of expert human performance has been well documented by Ericsson, Krampe, and Tesch-Roemer (1993), and has more recently been extended to adaptive thinking behaviors of military commanders (Shadrick & Lussier, 2004) and to naturalistic, intuitive decision making (Klein, 2003). Moreover, there is far less overhead needed to engender cognitive realism in a simulation (as described in the next section) than is required for immersive realism in a virtual simulation. Development of an immersive, virtual reality simulation can require large amounts of time and money, as well as skilled software engineers. The overhead incurred in developing virtual simulations make them hard to maintain and almost impossible to adjust for changes that inevitably occur in required training tasks and conditions.

Research Approach

We describe three sets of interrelated issues and techniques in this research and development effort in detail below before turning to a more general description of tool itself. These three aspects of the research approach guided our development of the SimFX tool.

Cognitive Realism

Realism is an essential component of simulation-based training. For many computer-based simulations, this realism is accomplished with the construction of a highly detailed, carefully rendered, synthetic or virtual environment coupled with some sort of input device that allows the student to interact with the simulated environment. This virtual reality permits the student to explore the simulated training environment in real-time, in perceptual and response situations similar to those that may be encountered in the real world. The actual sequence of situations encountered in the immersive virtual simulation is determined by propagating the effects of student decisions and actions in a predictive model that includes autonomous intelligent support and opposition agents. In principle, anything the student might do in the actual environment could be done via simulation in a virtual environment. As long as the simulated environment reflects the salient interactions of the actual environment, the student can gain valuable experience performing tasks that are either too dangerous or too expensive to perform in the actual environment. While effective for some types of training, immersion in a virtual reality comes with its own issues and significant overhead that do not justify its application in every training domain. (In fact, it is not

clear that highly realistic synthetic environments provide useful training for dismounted Infantry leaders, cf., Beal & Christ, 2004 and Pleban & Salvetti, 2003).

Outcome-driven simulation has recently emerged as one possible alternative to an immersive simulation (Gordon, 2004). In outcome-driven simulation the goal is no longer to immerse the student in a predictive, model-driven virtual reality but, rather, to exploit the cognitive realism that follows from engaging the student in a story or vignette. The student must make a series of decisions that moves the story forward in time to new situations that are relevant to the training objectives. The user-defined movement through the story ultimately affects how the story plays out. Outcome-driven simulation trades the continuous environment of virtual reality for a series of discrete choice points built into a narrative structure. By scripting together a series of choice points in a branching storyline, the training developer maintains control over the interactions between student and simulation. The branching storyline ensures that the student will encounter specific decisions at specific times rather than when they might be required during unprescribed movements through a virtual environment. However, crafting the branching storyline that constitutes an outcome-driven simulation places a burden on the developer to come up with an engaging yet tractable scenario. If the training developer constructs a scenario with too few choice points he runs the risk of constructing a simulation that is no more engaging than a short multiple choice exam. At the other extreme, if the developer tries to string together too many choice points he will quickly find himself lost in a combinatorial explosion of branches. The training developer must strike a balance between engaging the student and managing the complexity of a scenario while maintaining some semblance of continuous flow and believability throughout the scenario, no matter which choices the trainee makes.

Scenario-Based Training

Although a good deal has been written recently about the impacts of digital technologies and their implications for training, our work was motivated by the well established principle that expertise is generally built on a foundation of practical experience. So, rather than focus training on the specifications and capabilities of new digital technologies – the knobology of new technology – we set out to provide students with computer-based scenarios that would force them to resolve ambiguous or contradictory sensor readings, fuse disparate sources of information, filter information, manage resources (e.g., time, network bandwidth) and learn how to employ sensors to the greatest effect in a tactical situation.

For example, at one decision point we might ask the student to pick among three routes to a waypoint. The paths are presented on an electronic display of a map. The student has the ability to query various information sources. In addition to traditional information sources (e.g., an operations order, radio communications, map overlays), the student can query unattended acoustic sensors, visual reconnaissance from unmanned air and ground vehicles, and spot reports from a densely connected communications network. Choosing the correct path means querying the appropriate sensor and making good use of the information it provides. In this case, the situation was crafted so that the student must recognize that the indication of foot traffic reported

by an unattended acoustic sensor in the vicinity of one route is inherently ambiguous and that the determination of whether it is due to enemy or friendly activity along the route depends on querying another sensor – perhaps inspecting recent aerial reconnaissance. The choice can be further complicated by layering tactical considerations and time management demands (e.g., the shortest route offers less cover).

Although seemingly straightforward, implementing this decision point depended on the solutions to several interrelated questions. First, we had to decide how information would be presented. While we wanted to preserve the "look and feel" of the information sources, we didn't want the student to become mired in the painstaking analysis of a grainy reconnaissance photograph or the interpretation of a particular acoustic signature in a noisy signal. Instead, we opted to present information from these sources abstractly (usually as text-based reports from a notional intelligence analyst who reviews sensor data), to emphasize how the student should integrate such facts once presented rather than train interpretation of raw data. More generally, the abstract representation reflects the desire to steer away from a detailed underlying model where a consistent "world state" can be maintained and presented to the student (via additional and comparatively complex sensor models). Instead, the training developer simply specifies the information provided to the student at each decision point, tweaks the simulated world as necessary (e.g., adding enemies at a location, removing assets), much in the same way that an observer-controller will change the course of a live training exercise to suit the training objectives. But while the training developer gains greater control of the simulation in this way, it comes at a cost. Without detailed, underlying models to maintain a consistent world state, it falls on the training developer to manage the complexity and consistency of the unfolding scenario. As indicated above, managing this complexity is difficult.

Managing Complexity in Scenarios

Even with only a few choices at each decision point, keeping track of all the possible paths through a scenario may become unmanageable after a handful of decisions. While some degree of combinatorial explosion is inevitable, it can be minimized in a number of ways. First, as Gordon (2004) describes, a branching scenario can be pruned by introducing "chapters" whereby a series of decisions ultimately funnel back to a single decision. For example, we ask the student a short series of questions, each of which asks where he would move to next, given the available information sources (which can change from decision to decision). But rather than ramify the student's decisions throughout the entire scenario, we introduce a new series of questions by discontinuously moving the student to a new location that could plausibly be reached no matter which route the student chose previously.

A second technique for minimizing combinatorial explosion is simply to avoid it in the first place by posing non-branching decisions. Such decisions either ask the student to provide factual responses about digital technologies (e.g., "Can your unmanned acoustic sensor field at the objective detect truck traffic on the road just east of the objective?") or to estimate the resources required to execute particular phases of

the mission. Alternately, we could use rhetorical strategies to force the student to deepen his thought about the tactical situation (e.g., “Have you considered how your operational tempo would be affected if you were flanked en route to the objective?”). While the student will be prompted for a response, the response does not change how the scenario advances.

Finally, borrowing techniques from the gaming community, we have found it is possible to present the student with a seemingly genuine decision (i.e., a choice that affects outcomes) without having to represent those outcomes in the scenario. The trick here is not to predicate the outcome of the decision on what the student actually chooses, but rather, on what the student knew or should have known before he made his choice (which we can infer by keeping track of which information assets were queried). In much the same way as a video game designer will program a monster to appear in whatever room the player enters, we can ensure that bad things will happen whenever a student fails to make the best use of the information assets at his disposal.

Returning to our earlier example, independent of the route the student actually chooses, we can introduce an enemy ambush whenever the student fails to disambiguate the reports from his acoustic sensors. Conversely, the enemy will be absent whenever the appropriate combination of sensors is queried and we will reward the student for recognizing the original ambiguity, thus reinforcing the training objective. While this style of question requires the training developer to specify training feedback (i.e., outcomes) for a potentially large number of sensor combinations, it allows large parts of scenarios to be developed without any branching, and so the level of effort tends to grow linearly rather than exponentially in the depth of the scenario.

Description of the SimFX Tool

The development of SimFX took advantage of all three aspects of the research approach. SimFX is actually two software components: a Player component that presents a training scenario to a student and an Author component that allows the trainer to build the training scenario that meets the training objectives. The following sections describe both the Player and the Author components.

From the Trainee's Perspective

We currently envision two basic types of decision training exercises. However, SimFX is flexible enough that we would not be surprised if training developers find other ways to use it to train decision-making skills.

The first type of exercise is based on the branching storyline that we have been discussing in this report. In this type of exercise, the trainee is first given a description of the mission. This description can range from a brief and informal statement of the purpose of the mission with expectations of what constitutes a successful mission to a formal five paragraph operations order. When the trainee is ready to begin the mission, the scenario jumps to the first decision point. Using the player component of SimFX,

the student interacts with the simulation via a decision dialog window (see the upper left window in Figure 1) and a map display with buttons for querying sensors (see the large window on the right side of the figure). The decision dialog provides a description of the current situation, and a set of alternative courses of action. After reading the decision prompt and information contained in the map display, the student may query one or more sensors (human or robotic) before he selects an alternative and presses the Continue button. The selected sensors may provide additional information in a text messages window (see the window at the bottom of Figure 1) that can help the student make an optimal decision. Based on the student's inputs, SimFX displays the next decision dialog window. This dialog window first presents a critique of the student's previous decision and a narrative fragment describing the consequences of that decision in terms of the unfolding story. Secondly, this decision dialog window moves the scenario to the next decision point by describing the new situation and a new set of decision alternatives. This process continues until the mission ends in success or failure.

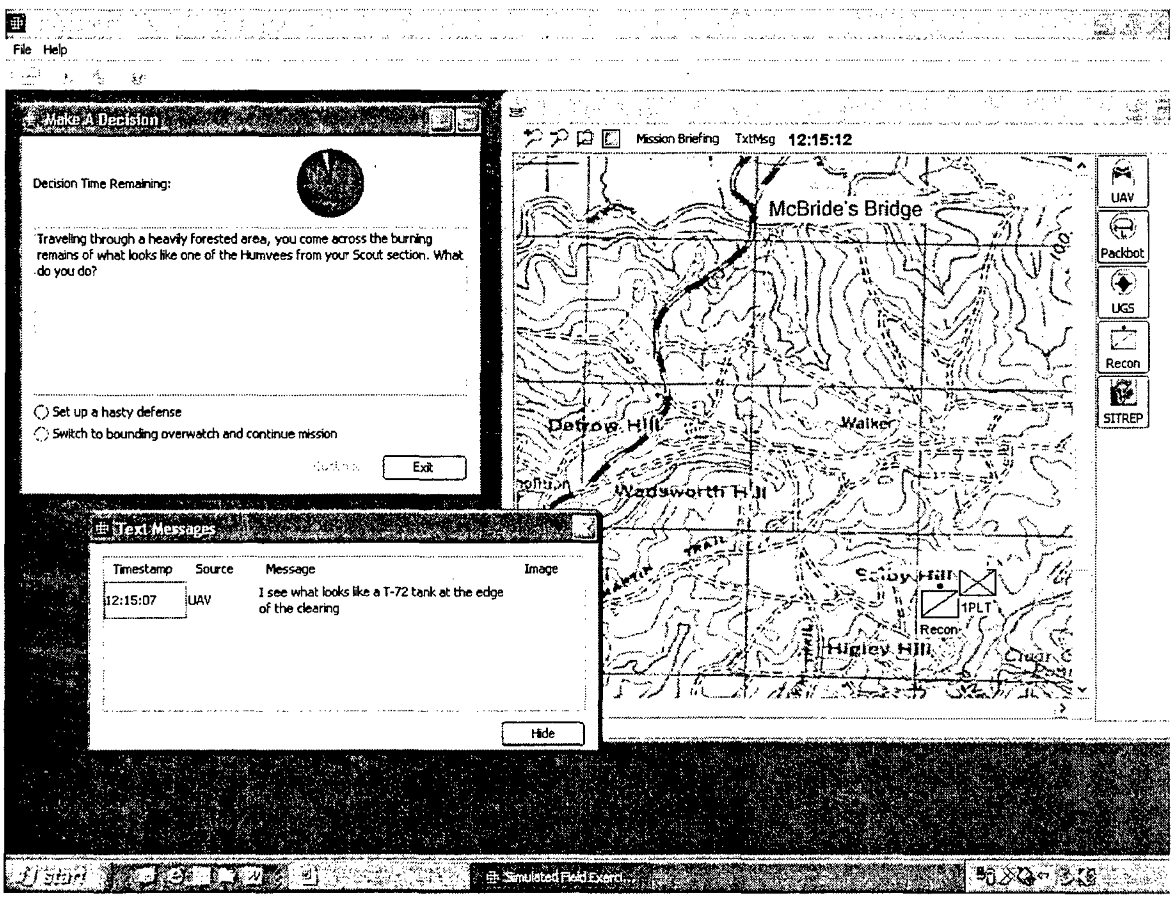

Figure 1. A SimFX screen typical of those presented in a story-based scenario. In this figure, a decision dialog window is shown in the upper left, a map and sensor query window is shown on the right, and a text message window is shown at the bottom.

The second type of training exercise is called deliberate practice. Deliberate practice exercises do not follow a branching storyline. Trainees are presented repeatedly with the same stand-alone decisions but with different information accompanying each decision. The trainee still needs to analyze different pieces of information to make a good decision. For example, when a leader is given visual information about a situation from a source other than his direct perception of the situation, such as a photograph or a segment of streaming video, it is very easy for the leader to become confused and disoriented about the point of view that is depicted. Deliberate practice exercises could show the trainee aerial photographs of the same situation taken from different perspectives and ask him questions regarding the different photographs. Feedback, along with an explanation of the relevant cues, gives the trainee practice at fusing information from two different perceptual points of view. Figure 2 shows two aerial photograph of the same urban scene taken from different visual perspectives. The decision dialog window identifies a truck shown in each photograph and asks the trainee if it is the same truck seen from two different directions or if the two photographs show two different trucks. Trainees can be shown many sets of photos with similar questions to practice making visual sense of information from different perspectives (to include combinations of aerial and ground-level views).

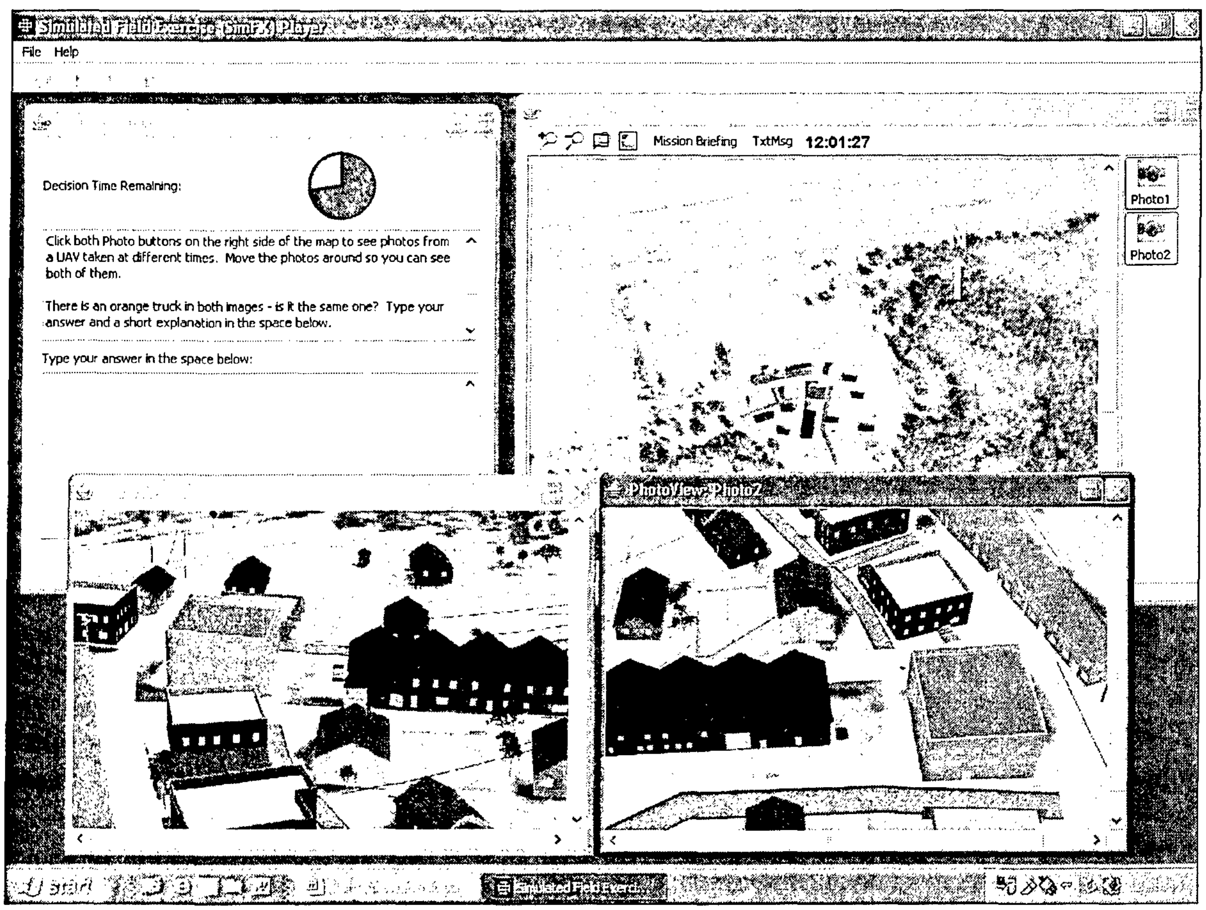

Figure 2. A SimFX screen used in a deliberate practice exercise. A decision window is shown in the upper left and a high altitude aerial photograph in the upper right. Two low level aerial photographs are shown for comparison at the bottom of the screen.

From the Training Developer's Perspective

Authoring Process

In order to create a story-based experience for the student, the author constructs a branching storyline composed of linked decision nodes. At each decision node, the scenario author must confront the student with a decision to make, provide some context to orient the student in the story, make available some information assets to assist in making the decision, and provide some narrative fragments that critique the student's choices and describe their consequences. The *SimFX Author User Guide and Tutorial* (Archer et al., 2006c) provides extensive guidance on the important points to consider at each decision point. In addition, an authoring template, such as the one we created for our sample scenario builders (see Appendix A), can be created to serve as a performance aid during the development of SimFX scenarios.

Typically, the author begins by sketching out the overall shape of the story. Gordon (2004) suggests a method that involves distilling teaching points from a collection of anecdotes, setting up decisions to support those teaching points, and then crafting the story around the decisions. Our process was similar but more iterative since we repeatedly found ourselves in a chicken and egg situation, wanting to build the story around decision points, but needing a basic storyline in place to motivate decisions. We found it useful to start with what we called the "happy path," in which the student makes only good choices and succeeds in his mission. Then, we would go back and introduce branches, based on suboptimal decisions, which lead to less favorable alternative endings. Part of an example story graph for one of our scenarios is shown in Figure 3. This figure shows a decision tree with eight nodes, most of which are reached through decisions made by the trainee but some, e.g., ambush, are

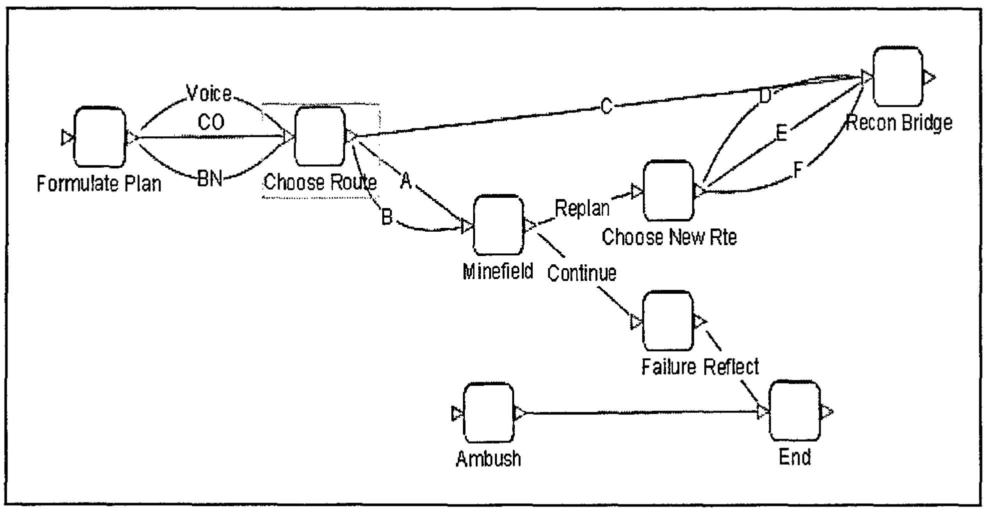

Figure 3. An example of an eight-node story graph. Successive nodes connected by links are based on the decision options selected by the trainee or a combination of decisions and information queries.

reached though a combination of the decision options the trainee selects and the specific combination of information assets the trainee queries. The box shown around the Choose Route decision node indicates that this node has been selected by the training developer for authoring.

The authoring of an individual decision node begins by brainstorming various ways in which the decision prompt, the decision alternatives provided, and the information sensors made available can be combined to support a particular teaching point The prompt must provide some "back-story" to make the decision cognitively engaging, and the decision alternatives must all seem equally plausible. We discovered that decisions having several answers with varying degrees of "goodness" made for more challenging scenarios than ones with a single right answer and several wrong ones. In the story graph, the decision alternatives are used to label the outbound links from a decision node. The scenario author specifies the properties of a decision node (e.g., its name, the time available to make the decision, and the decision prompt) using the Decision Properties dialog box, as illustrated in Figure 4.

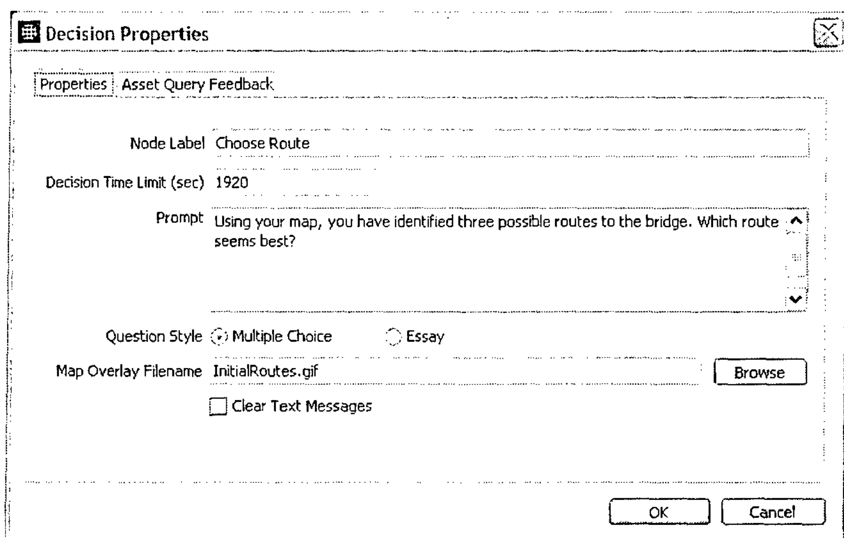

Figure 4. A decision properties dialog box. This dialog box is keyed to the Choose Route decision node shown in Figure 3.

Referring to the Choose Route decision node shown in Figure 3, we set up the decision to have three route choices. As Figure 3 shows, Routes A and B eventually lead to a minefield, while Route C bypasses it. The decision prompt we used for this decision node is shown in Figure 4. It provides a bit of context but no direct information about any of the routes. The student must not only choose well given the decision alternatives, he must also make good use of additional information available to him from the information assets provided. In this specific example scenario, we provided the decision maker with an Unmanned Aerial Vehicle (UAV) to fly over any or all of the three routes and an Unattended Ground Sensor (UGS) located near Route C.

The teaching point we wanted to support in this decision is that often one source of information is not enough to provide a clear picture of the situation. However, simply querying all available information assets at each decision point is not a viable strategy either, since some assets – the UAV for example – can be costly in mission time and resources to deploy. Therefore, the student must learn to discern which information sources are most appropriate to query for a given situation.

In our example, the student must choose one of the three alternative routes, and can decide to query or not query each of four different sources of information – aerial reconnaissance, using the UAV, on each of the three routes, plus the unattended ground sensor. SimFX uses the Asset Query Feedback tab on the Decision Properties dialog box shown in Figure 4 to tabulate compactly the various combinations of decision choices and assets selected, and to specify a unique result for each combination of student inputs. A sample table of the Asset Query Feedback dialog box for the Choose Route decision node is shown in Figure 5.

Rules	Choice	UGS1	UAV/Route B	UAV/Route A	UAV/Route C	Result	NextNode
	A	Don't Care	Don't Care	No	Don't Care	R1	
	A	Don't Care	Don't Care	Yes	Don't Care	R2	
	B	Don't Care	No	Don't Care	Don't Care	R3	
	B	Don't Care	Yes	Don't Care	Don't Care	R4	
	C	No	Don't Care	Don't Care	No	R5	Ambush
	C	No	Don't Care	Don't Care	Yes	R6	
	C	Yes	Don't Care	Don't Care	No	R7	
	C	Yes	Don't Care	Don't Care	Yes	R8	

Figure 5. A decision rules table. This decision rules table is keyed to the Choose Route decision node shown in Figure 3.

The first 5 columns in the rules table correspond to student inputs – the decision alternative he selects and the sensors he does or does not query. When the student makes his decision, SimFX examines the rows in the table in order, starting at the top, looking for a row in which entries in the first 5 columns match what the student actually did. In addition to Yes and No as possible values for a sensor query, "Don't Care" can be used to indicate that it is irrelevant whether the student queried the corresponding sensor. The use of Don't Care entries can greatly reduce the number of rows in the decision table, thereby reducing its complexity and the effort required to create it.

When a match is found, a corresponding results table in the Assets Query Feedback dialog box, such as that illustrated in Figure 6, is used to identify the text the author has prepared for each possible result. This text will be presented to the student as feedback (i.e., the critique and consequences of a decision) to the student for his inputs for this decision node, along with the prompt for the next decision node. Figure 6 shows some examples of feedback the student would get depending upon his input to the Choose Route decision node of the story graph shown in Figure 3. For example, if the student queries the UGS but not the UAV along Route C, then chooses Route C, the seventh row in the input tabulation table matches and the narrative associated with

Result R7 (see Figure 6) is displayed as feedback to the student for his inputs to the Choose Route decision along with the prompt for the next decision.

Results	ID	Text
	R5	The map showed this route to be the longest. Moreover, had you used your sensors, you would have learned of the presence of an enemy patrol along the route. En route, you are attacked and overwhelmed. There are no survivors.
	R6	As your aerial recon indicated, the route is clear except for some local noncombatants.
	R7	As the report from your unattended ground sensor indicated, there has been recent foot traffic along the route. It would have been wise to employ your UAV to attempt to determine if that foot traffic represented a threat. Fortunately, you arrive at the bridge without incident.
	R8	Good choice. Route C is a reasonable route, and your use of the UAV to confirm that the foot traffic detected by the UGS was not a threat was wise.

Figure 6. A sample of a decision results table. This decision results table is keyed to the Choose Route decision node shown in Figure 3.

All of these narrative elements – the prompt, the choices, the available sensors, and the outcome and critical feedback – must support the particular teaching point associated with the decision. In addition, the outcome and feedback must fit seamlessly together with the prompt for the next decision in the graph, so that the student is presented with a coherent, cohesive story from beginning to end, no matter which path he takes through the story.

We discovered that constructing a scenario which is not easy to “game” requires great care. As mentioned previously, decisions must be framed in a way that the best answer is not obvious, and that “always query all sensors” is not a successful strategy. Time pressure also makes the simulation hard to game and increases student engagement. In SimFX, we created two countdown clocks – one that limits the amount of time available for each decision, and another that limits the total time available to accomplish the mission. Our experience with an early beta test confirmed that time pressure was a significant factor in making the scenarios hard enough to be interesting.

While we have not introduced the concept of scoring decision performance into this version of SimFX, it would be straightforward to allow the author to attach a positive or negative value to each row in decision tables such as that illustrated in Figure 5, and display the cumulative score at the end of a training session. SimFX does create a report showing the decision choices and information asset selections of each student at each choice point. This information can be used as part of an after-action review with an instructor.

SimFX Authoring Principles

In the process of creating multiple training exercises we have learned a lot about how to use the SimFX tool to create and modify story-based and deliberate practice

scenarios. Based on these experiences, we have developed some principles that appear to be quite useful. These authoring principles are described in subsequent paragraphs.

Use the "back-story" (decision prompt) to provide cues and motivate the decision. Back-story describes the situation which calls for a decision and perhaps provides some relevant cues. Digital information will be most useful to small unit leaders when they are in the middle of a "planning break", rather than actively navigating terrain or engaging the enemy. Therefore, the decision prompt should cast the trainee in the middle of one of these brief pauses in mission execution. For example, consider "traveling through a heavily wooded area, you come across the burning remains of a Humvee". This is a situation that calls for some kind of action; the trainee should not merely proceed with the mission. The fact that the area is heavily wooded may be significant (for example, using a UAV may be ill-advised because of a dense tree canopy).

Craft decision options carefully to support the decision's teaching point. Make decision alternatives equally plausible, so that the best answer is not obvious. If the trainee can guess the right answer, no real training transfer is likely to occur. Often, it's best to create decision options in "shades of gray" – optimal, near-optimal, and suboptimal – rather than one "right" and several "wrong" options. This approach reflects the truth that in real life, there is almost always more than one way to solve a problem. For scenarios to be realistic, different optimal or near-optimal choices should have different consequences – sometimes ones that show up much later in the scenario. Be careful not to give away information in the decision options that the trainee should be able to find out only by using information assets – for example, an option like "dispatch SUGV [small unmanned ground vehicle] to observe gathering crowd" when the trainee has no idea there is a crowd.

Don't mix asset queries with decision options. It may be tempting to create decision options like "Deploy your UAV" and "Send out a Recon Squad". This approach is not necessarily incorrect, but it fails to take advantage of many of the capabilities SimFX has to create engaging scenarios. If asset deployment is tied to decision options, the trainee will not have the option of querying none, one, or both. He will always have to pick just one. Thus, no information fusion (combining information from multiple assets) can be taught. Generally speaking, making assets available to the trainee via the asset toolbar, rather than through decision options, will result in more interesting scenarios.

Choose assets so that the trainee must fuse the right information in the right way. In the future battlespace, leaders will need to reconcile disparate data sources, filter out and select relevant information, diagnose inconsistencies and contradictions across the data, and deal with ambiguous, missing, or erroneous sensor information. Challenging the trainee with these kinds of problems will result in engaging scenarios that result in training transfer.

Set up situations that require the development of spatial orientation skills. Spatial orientation will become a key issue and skill in the electronic battlefield. A leader in the future high technology force will need to understand the data being sent to him from the sensor's point of view and then translate that into information that he can use to make a correct decision. If the leader is even slightly disoriented as to where a sensor is looking with relation to him, the results could be disastrous.

Use time pressure to create a sense of urgency and prevent "gaming the system." Adjust the time available for each decision such that the trainee only has time to query the particular combination of information assets whose output you want the trainee to fuse to come to a correct decision. This prevents the trainee from using the obvious success strategy of querying every asset at every decision point, which will simply not be possible in a real combat situation. Querying an asset should carry with it a cost in terms of time, and the decision should usually not allow enough time to query all information assets. In addition, identify just a few optimal and near-optimal paths through the scenario, and adjust the between-decision (link) times and overall mission time available so that it is just barely possible to complete these paths. Adjust the link times on sub-optimal paths so that the trainee will run out of mission time if he takes them. Using time pressure in this way will make your scenarios more engaging and more likely to force the trainee to think carefully about his actions and learn from his mistakes.

Evaluation of SimFX Usability

We conducted a series of beta tests to gauge the usability of SimFX and the likelihood that it could deliver useful training. The beta test procedures and findings for both the SimFX Player and the SimFX Author are described below.

Internal Beta Test and Focus Group for the SimFX Player

An internal beta test of the SimFX Player component of SimFX was conducted using employees of Micro Analysis and Design, Inc. The goals of these tests were to: (a) Discover confusing aspects of the Player component; (b) Uncover misconceptions about Player and the training objectives; and (c) Discover inconsistencies in the scenario. Six personnel participated in the beta test. The participants varied in their level of computer skills and their familiarity with the Army's Future Force systems. The participants included: two former platoon leaders in the Army, an office manager; an entry-level systems engineer; a high-level applications engineer who works on military simulation products; and a senior analyst who works on the development of Future Force robotic systems.

Participants were given a brief description of the purpose of the SimFX Player component and how it worked. After installing the software, the participants went through the beta test scenario multiple times, noting anything that was confusing or unexpected. This activity took between one and two hours. When all the participants were finished, a group debrief was conducted in which we elicited details about the

experiences they had while using the Player component. The following questions were asked at the debrief:

- In your words, what was the purpose of this component of SimFX? What would you guess we were trying to accomplish?
- What did you like best about Player?
- Tell about a time when the things did not work how you expected? Explain.
- Tell about a time when you where confused? Explain.
- What was frustrating about the Player component of SimFX or the scenario?
- Was there a time when something happened in the scenario that just didn't make sense?
- If you could change one thing about this component of SimFX what would it be?
- Tell me some things you learned about using robotic sensors?
- What do you know now that you didn't know before going through the scenario?
- We want to make it easy for people to navigate though Player and understand what actions they can take. What advice or directions should we give people before they sit down to use Player?

Participants indicated that they correctly understood that the purpose of the Player component of SimFX was to prepare the decision maker for a real life situation in which they would need to use robotic assets. SimFX helped them understand what resources they had and how to use them. The participants also learned specific things about the employment of assets. These would vary depending on the scenario and the learning objectives of the developer. As an example, one participant said they learned to look for text messages because they often contained critical information. Another participant learned that UAVs take longer to gather information than some of the other resources.

There were several aspects of the Player and scenario that were confusing. We modified the software to fix confusions related to the scenario. For example, an asset may have been available at one decision point, not available at the second, and then available again on third decision. We revised the scenario so this was more consistent or at least explained (i.e., the unmanned ground vehicle (UGV) is not available because of bandwidth limitations in hilly terrain). In terms of the Player component, participants agreed that they needed to play the scenario three to four times before they felt like they knew what they were doing. In addition, there were multiple assets (such as text messages, SITREPs, and biosensors) that the participants did not notice the first time using the Player. We considered this to be beneficial for several reasons. First of all, it is our not our intent to train users completely in one run on a scenario. The scenarios are meant to be exploratory in that trainees learn by trial and error and by noticing trends in how the use of assets and information impacts outcomes. Secondly, we know that no matter how well designed, the systems that convey digital information in the future will have features that are confusing and non-intuitive on the first try. By practicing with SimFX, small unit leaders will be better prepared to deal with the

confusion and uncertainty that are inherent during a mission. Small unit leaders will learn how to seek the information they need and which types of information are most useful in different situations.

One of the key findings from these in-house beta tests was the fact that there was not enough time pressure. In almost every decision, participants had plenty of time to use every robotic resource available. It was our intent that participants would run out of time if they queried every asset. Therefore, we revised the timing in the beta (and subsequent) scenarios to ensure there was sufficient time pressure. Participants identified specific technical problems such as the inability to see gridline references in the initial map. They also made suggestions on how to improve the interface, such as being able to mouse over an asset to get additional details on its capabilities. These problems and suggestions were addressed in subsequent versions of SimFX.

Overall, the internal beta group agreed that SimFX had a solid approach. The branching seemed robust and there were enough paths and options to keep the participants engaged for multiple runs through the scenario. Most problems were fixed by decreasing the decision times and thereby increasing the time pressure.

Beta Test for the SimFX Author

The beta test of the SimFX Author component was conducted over a six month period as part of a spiral development. Three personnel participated in a beta test by using the SimFX Author to create a scenario from scratch. These included: a subject matter expert contractor with 20 years active duty in the Army, a contractor for ARI, and a documentation specialist. Two of these beta testers, the Army subject matter expert and the ARI contractor, used SimFX to author two scenarios. An analyst at Micro Analysis and Design served as the fourth beta test participant. Instead of creating a scenario from scratch, this participant was responsible for inputting a pre-defined scenario into SimFX. The scenario had been previously specified using the Decision Template we developed (see Appendix A) and needed to be converted into a SimFX scenario. This participant also used SimFX Author to make adjustments to several other scenarios – both branching stories and deliberate practice scenarios.

The beta test of the Author component occurred at different times in its development. We implemented most of the suggestions from the beta testers. Some suggestions pertained to how things worked in SimFX. For example, in addition to being able to send a SITREP to higher headquarters, a player in the game can now send an order to subordinates. Also, training developers can now play the scenario they are creating directly in the Author component of SimFX. This ability to verify that the scenario is working as intended has greatly streamlined the scenario development process. Feedback from the beta testers was also used to fix minor human factors issues. For example, the appearance of buttons was revised to make it more obvious that they were buttons and labels were changed to make their functionality more obvious.

Our own experience using the author component of SimFX, coupled with feedback from the beta group, prompted us to create aids to assist in the authoring process. It became clear that authoring scenarios was a difficult task, whether it was done within SimFX or via pencil and paper. To compensate for this, we created a Decision Template (see Appendix A) that guides a scenario developer through the important considerations of every decision. In addition, a SimFX author user guide was developed that walks training developers through the authoring process. The guide includes a tutorial using a concrete example, as well as authoring principles or "lessons learned" to help the developer get the most impact out of his or her training.

Beta Test for SimFX Player and Author During a Workshop at Fort Benning

We conducted a workshop at Fort Benning, Georgia, with a group of 30 participants drawn from a broad cross section of the Infantry training and training development communities. While a detailed description of the Fort Benning beta test of SimFX has already been published (Christ, 2006), this section summarizes the procedures and results of that evaluation so that all the relevant usability research is reported together in one report.

During the workshop we first described our motivations and visions for SimFX. We then walked the participants through the SimFX beta software to demonstrate both the training and authoring capabilities of the tool. Workshop participants were given a chance to experience a variety of SimFX training scenarios first hand. These included a story-based scenario aimed at training general information fusion skills, and two deliberate practice exercises targeting specific skills. The participants also had a hands-n demonstration of how the Author component of SimFX could be used to create a simple three-node scenario. After a period of relatively unstructured exploration, we asked the participants to complete a questionnaire.

The questionnaire was developed to capture the opinions of the participants about their experiences with SimFX during the workshop. Successive parts of the questionnaire asked the respondents to rate the:

- The training value of SimFX.
- The extent to which users of SimFX would be personally involved with the training.
- The ease of use or the usability of SimFX for training and for editing or authoring a training scenario.

Participants were also asked to provide written comments about SimFX in terms of its advantages and disadvantages as an aid for training and as a method for editing or authoring training scenarios.

Nineteen participants completed the questionnaire. In general, the opinions they expressed about SimFX were positive. Eleven questions asked about the training value of SimFX using a seven-point scale ranging from three decreasingly negative opinions,

though a neutral rating category, to three increasingly positive opinions. Between 68 and 95 percent of the respondents used one of the three highest rating categories to indicate they had positive opinions about the training value of SimFX. Five questions using a similar seven-point scale asked about the capability of SimFX to fully engage or involve the user. Between 52 and 95 percent of the respondents used one of the three highest rating categories for these items to indicate that they believed SimFX would capture the attention and motivation of trainees. Finally, participants were asked to indicate their level of agreement with twenty-five positive statements about the usability of SimFX using a five-point rating scale. Between 61 and 100 percent of the respondents either agreed or strongly agreed with these positive statements indicating that they believed SimFX was usable for training and for authoring training scenarios.

The respondents' written comments about SimFX training followed a pattern similar to their rated opinions, with a majority of positive comments reflecting, among other things, the ease of use, the emphasis on the training decision-making skills, and the potential to modify existing SimFX scenarios to fit new training requirements. Some of the negative comments concerned details specific to the training scenario we demonstrated. In particular, many of the respondents were unfamiliar with the capabilities of the remote and robotic sensor technologies, which played a central role in our demonstration scenarios. Other negative comments hit on issues common to many training tools such as the difficulty inherent in developing good training, the lack of access to computers in the field, and a preference for live training.

Written comments about the authoring capability in SimFX were less positive, with many respondents expressing concerns about the perceived difficulty of authoring. However, compared to the discussion of training with SimFX, the authoring discussion received short shrift during the workshop, so these comments are not entirely surprising. At the same time, some respondents indicated that, with a little practice, they thought authoring might not be too onerous, especially given an existing scenario to modify.

Finally, our beta test at Fort Benning uncovered an application for SimFX we had not considered. Several participants pointed out the potential for using SimFX as a general method for creating and modifying training scenarios that could be used in another training environment. Quite often, such development is undertaken using paper and pencil story boards or carefully constructed PowerPoint presentations. The decision point editor and the compact representation of the branching logic within the authoring component of SimFX provides a more flexible scenario development environment, while the Player component of the SimFX tool could serve as a "playback" environment.

Conclusion

Given the findings discussed above regarding the numerous and varied beta tests, as well as the experiences that our project team have had throughout the

development cycle, we conclude that the SimFX tool and the training development methodology surrounding it can have a potentially positive impact for training present and future small unit leaders to make rapid decisions while fusing information from disparate sources. The SimFX tool puts the focus on cognitive realism instead of immersive virtual realism for training, resulting in a light-weight application.

While our approach places a non-trivial demand on the training developer to produce a well-crafted, outcome-driven scenario, the required effort pales in comparison to that required to develop, maintain, and use more immersive simulation environments. At the other extreme, we are inspired by a generation of paper and pencil exercises, called Tactical Decision Games, which the U.S. Marines use to get students to suspend disbelief and engage the story behind the training scenario. We see the outcome-driven simulation approach that we have built into the SimFX tool as a middle road between highly immersive virtual simulation exercises and pencil-and-paper exercises.

Features of the SimFX authoring component also emphasize sound educational principles and techniques for training leaders to use digital technologies (Graham & Dyer, 2002), such as the use of well crafted teaching points, advanced organizers and constructive feedback. The SimFX approach is designed to be used directly by training developers with domain expertise, as opposed to having training application development primarily in the hands of software engineers.

We have encountered several instances where people were interested in SimFX as a method for authoring branching scenarios that are not necessarily for training digital information fusion. As noted earlier, the most popular means for general scenario authoring seem to be paper and pencil story boards or PowerPoint presentations. SimFX provides a much more flexible and sophisticated scenario development and playback environment than is possible with these more common authoring methods.

Finally, we conclude that, although SimFX was developed for the Army, with Army Infantry leaders in mind, it could also easily be adapted to other instances where crucial decisions have to be made using widely varying sources of information. Intended users of SimFX could be expanded to include other military services, police forces, disaster management, and homeland security incidents.

References

Archer, R., Brockett, A. T., McDermott, P. L., & Warwick, W. (2006a) *Simulated Field Exercise (SimFX) Tool* (Research Product 2006-06). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Archer, R., Brockett, A. T., McDermott, P. L., & Warwick, W. (2006b). *SimFX Player user guide and tutorial* (Research Product 2006-07). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Archer, R., Brockett, A. T., McDermott, P. L., & Warwick, W. (2006c). *SimFX Author user guide and tutorial* (Research Product 2006-07). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.

Beal, S. A. (2005). *Using games for training dismounted light infantry leaders: Emergent questions and lessons learned* (Research Report 1841). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (ADA 438042)

Beal, S. A., & Christ, R. E. (2004). *Training effectiveness evaluation of the Full Spectrum Command game* (Technical Report 1140). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (ADA 419670)

Beal, S. A., & Christ, R. E. (2005). *Soldier perceptions of the Rapid Decision Trainer* (Research Report 1835). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (ADA 436993)

Centric, J. H., Beal, S. A., & Christ, R. E. (2005). *Train-the-trainer package for the Full Spectrum Warrior game* (Research Product 2005-02). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (ADA 428443)

Christ, R. E. (2006). *Preliminary evaluation of a novel simulation-based tool for training rapid decision-making skills* (Research Report 1847). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (ADA 443863)

Ericsson, K. A., Krampe, R. T., & Tesch-Roemer, W. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review, 100*, 363-406.

Gordon, A. S. (2004). Authoring branching storylines for training applications. In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A. S. Nixon, & F. Herrera (Eds.), *Proceedings of the International Conference of the Learning Sciences (ICLS-2004*; pp.230-237). Mahwah, NJ: Lawrence Erlbaum Associates. (Paper was also retrieved July 18, 2006, from www.ict.usc.edu/~gordon/ICLS04.PDF.)

Graham, S. E., & Dyer, J. L. (2002). Objective force warrior: New ways to train. *Army AL&T Magazine*, March-April 2002, pp 8-9.

Klein, G. (2003). *The power of intuition: How to use your gut feelings to make better decisions at work*. New York, NY: Currency Books - Doubleday.

Pleban, R. J., & Salvetti, J. (2003). *Using virtual environments for conducting small unit dismounted mission rehearsals* (Research Report 1806). Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (ADA 415298)

Shadrick, S. B., & Lussier, J. W. 2004. *Assessment of the think like a commander training program.* ARI RR 1824, Arlington, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (ADA 425737)

Appendix A

Decision Template

We developed the decision template presented in this appendix to serve as a performance aid for individuals who were creating training scenarios using the Author component of the Simulated Field Exercise (SimFX). The decision template guides the scenario developer through the important considerations that need to be made at every node in the decision graph.

Decision Point #n: *[Brief title describing the decision to be made]*

Teaching point:

[General principle, teaching point, learning objective]

Application of teaching point in this decision:

[How do the specifics of the way this decision is set up bring out the teaching point or accomplish the learning objective?]

Decision prompt:

[The actual prompt the trainee will see during scenario playback. Usually consists of two parts – first, some "back-story" describing the situation that motivates a decision, usually containing some important cues, and second, a description of the decision required of the trainee]

Decision time allowed:

[Usually set to just enough time for the trainee to query the assets (e.g. unmanned vehicles) needed to make the decision, plus perhaps one minute of "thinking time"]

Choices Available: (maximum of five)

CHOICE	NEXT DECISION POINT
[Brief phrase describing a choice]	*[# of next decision point if this alternative is chosen]*
[Brief phrase describing a choice]	
[Brief phrase describing a choice]	

Information Assets Available, Routes, Times, Reports, and Other Notes:

[This section lists the information assets that will be made available to the trainee. The information that should be specified for each information asset is described in the table below]

ASSET TYPE	**INFO TO SPECIFY**
SUGV, ARV, UAV	*Describe (or attach graphic) and name the possible routes associated with this vehicle.* *For each route, note whether any photographs or video clips are available. Describe each photograph or video clip, or provide graphic.* *For each route, specify how long the asset will take to complete it.* *For each route, give the text of the report from the "unmanned vehicle operator" after the route is complete – this will appear in the Text Message list for the trainee to see.*
ASSET TYPE	**INFO TO SPECIFY**
UGS	*Provide the text of the message that will be displayed to the trainee if he clicks on (queries) the UGS*
Recon Squad	*Provide the text of the message that will be displayed to the trainee if he clicks on (queries) the Recon Squad*
Generic Message (e.g. radio)	*Provide the text of the message that will be displayed to the trainee if he clicks on (queries) the Generic Message*
Map Overlay	*Give the name for the map overlay (e.g. fire support) and provide a graphic*
Pushed Message	*Pushed messages are messages which are automatically pushed into the text message queue when the scenario progresses to this decision point. Multiple messages can be provided here.* *By default, each message is time stamped with the current value of the mission clock. However, you can optionally specify that the time stamp should be some number of minutes ahead of or behind the mission clock, e.g. +45, -15*
SITREP	*There is no information that needs to be provided for the SITREP, other than that one should be an "asset" for this decision*
Observer	*Identify (on the map) the observation posts that will be available as locations to which the trainee can "send" the observer.* *For each observation post, note the message that will be sent to the trainee from an observer at that observation post*

Asset Query Feedback Rules:

ALTERNATIVE CHOSEN	ASSET 1	ASSET 2	ASSET N	RESULT
[First alternative from the Choices Available table above]	*Yes/No/ Don't Care*	*Yes/No/ Don't Care*	*Yes/No/ Don't Care*	*R1*
[Second alternative from the Choices Available table above]	*Yes/No/ Don't Care*	*Yes/No/ Don't Care*	*Yes/No/ Don't Care*	*R2*
Hasty Attack	*Yes*	*No*	*Don't Care*	*R3*

In this table, you can think of the rows as "rules" consisting of conditions and actions. The software starts at the top and goes down the list of rules, looking for one whose condition matches what the trainee actually did. The columns to the left of the Result column comprise the condition, while the Result column specifies the "action", which is always to display the corresponding line of text shown in the Result table.

The "condition columns" between the Choices and Results columns always correspond to sensors, or information assets, which can be as simple as a message from another unit. Entries in these columns are always one of: Yes, No, or Don't Care. A "Yes" entry matches the case where the trainee queried the information asset; a "No" matches the case where he didn't; and a "Don't Care" is a match whether the trainee did or did not query the asset.

Thus, taking the third row in the table above as an example, if during the course of this placeholder scenario, the trainee chooses Hasty Attack from the alternatives presented to him, and he DID check Asset 1 and DID NOT check Asset 2, the third rule matches and the feedback labeled R3 will be displayed. Note that since Asset n is "Don't' Care" in this row, there is a match regardless of what the trainee did with Asset n.

The table should account for every possible combination of trainee inputs. If the trainee's actions do not match any row in the table, no feedback will be given to him. The number of rows required is:

*(number of decision options) * 2^ (number of asset columns)*

*For example, if there are three decision alternatives, and a UGS and a UAV with two possible routes that can be queried, the number of rows in the decision table should be 3 * 2^3 = 24. The use of Don't Care entries can substantially reduce the number of rows in the table.*

Asset Query Feedback Text:

R1	*Text that should be displayed to the trainee as feedback*
R2	*Text that should be displayed to the trainee as feedback*
R3	*Text that should be displayed to the trainee as feedback*

Additional map graphics for this decision node:

Describe any graphics that should be added to the base map for this decision node. For example, if the decision asks the trainee to consider using a MEDEVAC helicopter, we may want to show its location on the map. These graphics are distinct from a "map overlay information asset" as described above, in that these graphics are always shown, without the trainee having to click on a button to see them.

Trade Space Analysis:

The trade space identifies three to five tradeoffs that the trainee should be thinking about in making this decision. We can adjust the "settings" of these factors in the decision prompt, and the correctness of the trainee's response depends on the settings. For example, for a decision about whether to use an organic Class I UAV or ask for a company level Class II UAV, the trade space might include range (how far is the trainee from the desired recon target? Can a Class I UAV go that far?), time ***on station*** *(can the UAV loiter until the trainee gets there?),* ***desired field of view*** *(Class II will likely fly higher and provide a wider but less detailed view), and* ***stealth*** *(higher flying UAVs are harder to see). The correct answer depends on how we tweak the particulars of the factors in the trade space.*

One of the benefits of this approach is that once we have crafted a decision, we can relatively easily create a whole "family" of similar but distinctly different decision points by varying the parameters in the trade space. In this way, we get significantly more mileage out of the effort required to set up a decision point.

The trade space can be described in narrative form, if desired, or a table such as this one can be used:

FACTOR	**MY CLASS I UAV**	**COMPANY'S CLASS II UAV**
Flight time	45 minutes	3 hours
Speed	60 kph	120 kph
Stealth	Audible and Visible	Inaudible, nearly invisible
Elevation/Field of view	200m/40 degrees – can resolve objects as small as a man	1500m/40 degrees – can resolve objects as small as a building
Availability	Use anytime	Must ask for permission, compete with other platoons for access